NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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TIMBER-SEASONING PRACTICES UNDER CONDITIONS OF HIGH HUMIDITY IN TROPICAL AREAS.

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1. The fundamentals of wood drying are not greatly influenced by climate, differences in timber species, drying processes, or geographic factors. However, seasoning practice is greatly concerned with such variants, because major considerations are the quality, speed, and economics of drying, often to the extent that procedures adequate for some areas are unsound for others. In tropical areas subject to high humidities most difficulties in seasoning are, in fact, posed by this climate, aggravated usually by frequent, heavy seasonal rains, and accentuated by insect and fungal attack. On the other hand, degrade due to excessively rapid drying can also occur in susceptible timbers, particularly round forms, during seasonal dry periods when temperatures remain high.

LOG PRE-TREATMENTS

2. The quality and recovery of sawn timber from logs in tropical areas are markedly affected by log storage conditions. Loss of quality can be caused by borer attack, splitting, and sapstaining which extends in some cases to decay. Pre-treatments are, therefore, often necessary especially during delay periods incidental to extraction after felling, or when prolonged storage is unavoidable.

3. These forms of degrade rarely reach serious proportions in round or sawn timber placed in pond storage quickly, or converted soon after felling and rapidly air- or kiln-dried. On the other hand, under warm humid conditions, sapstain or decay soon become serious in sapwood or susceptible heartwood stored in air while moisture contents remain above 30%, the extent and rate of attack depending on species, local climate, the particular conditions of exposure, and the rate of surface drying. Simultaneous insect attack is also common.

4. Protection from staining fungi, of which blue stain is the most important, can often be obtained by surface treatment with a suitable fungicide. Alternative methods of application are to de-bark and spray all surfaces, including ends with, say, either pentachlorphenol (2.0%) in a cheap mineral oil, or a water solution of sodium pentachlorphenate; or to retain bark and spray only the ends and those barrel surfaces from which the bark has been dislodged: in some respects the latter is possibly the better. For effective protection spraying must not be delayed beyond the day of felling.

5. Insect attack from pinhole borer (Ambrosia beetle) often occurs immediately after felling. Protection is generally based on a complete

spray treatment with benzene hexachloride (0.5% gamma isomer) or dieldrin (0.5%) in a mineral oil or as a water emulson. It is often necessary to incorporate a fungicide and insecticide in the one spray.

6. Where there is a risk of end-cracking during dry periods, log ends should be given a coating of a heavy petroleum grease and wax mixture in which a fungicide has been incorporated. This must be given immediately after an end has been sawn and may be applied as a fairly thick coat by a paddle or brush.

THE SEASONING OF SAWN TIMBERS FOR JOINERY, FURNITURE AND GENERAL BUILDING PURPOSES

Selection of the Seasoning Process

7. In general, for the bulk of wood-using industries operating under humid tropical conditions, choice of seasoning process is at present limited almost entirely to either air drying, pre-drying or kiln seasoning, or a combination of these. Which should be chosen is determined primarily from consideration of size of operation, stock dimensions, drying behaviour, drying time and urgency of demand.

8. Where air-drying conditions are favourable, as is frequently the case in tropical areas, and assuming provision is made for protecting stock from rain, air drying has much to recommend it from considerations of drying economy and dried quality. Its main disadvantages are the investment required in both stock and yard facilities, the time required, its lack of flexibility for urgent drying tasks and, under tropical conditions, the comparatively high moisture content at equilibrium, particularly during wet monsoonal periods.

9. However, economy in drying is only one of a considerable number of factors for consideration, and in many circumstances accelerated methods, even at greater cost, are more attractive.

10. Pre-drying should be considered as a substitute for, or to supplement, partial air drying to moisture contents in the vicinity of fibre saturation point. It has particular value where protection from rain cannot be provided and repeated re-wetting seriously interferes with processing operations dependent on pre-seasoning, e.g. pressure preservation treatments.

11. Kiln seasoning has as its main advantage speed in drying to low moisture contents after a preliminary period of air drying or pre-drying, and is especially useful for custom drying purposes, where stock must be kept to a minimum, or where export or plant manufacturing operations are dependent on a continuity of supply and final high dried quality.

Air Seasoning

12. For reasons of simplicity and economy, air drying must remain the most widely practised method of seasoning for many humid tropical areas for the foreseeable future. Its efficiency will depend largely on the attention given to details of stacking and yard practice, as unsatisfactory methods simply defeat their purpose and result in uneven drying, sapstain and, ultimately, decay. These hazards are naturally greatest in sapwood and the sawn products of susceptible species such as Gonystylus spp. For these, pre-seasoning prophylactic treatments are usually necessary as a measure of control. Accordingly, where susceptible

material has not previously been protected by a general purpose diffusion or pressure preservation treatment, it should be dipped or sprayed in a combined fungicide, such as sodium pentachlorphenate (0.5 to 1.0%) and borax (1.5 to 3.0%), and an insecticide soon after conversion. Timber should not be exposed to heavy rain immediately after treatment. The protection provided is limited to a few months.

13. Stacking practice in humid tropical areas aims to accelerate drying rates and prevent, as far as possible, the development of zones of high humidity in and around the stacks. Recommended practices therefore comprise all measures likely to promote air circulation. These include: a sticker thickness not less than 1 in; a limitation of stack width to not more than 5 ft; adequate side spacing between individual stacks, e.g. spacing not less than 2 ft where more than two stacks are adjacent; stack-end spacings to form continuous air channels and not less than 6 ft wide; stack foundations of pier and bearer construction of a height not less than 18 in from ground level to lowest stack layer; a stack height not greater than 10 ft; and a yard site well exposed to prevailing winds, thoroughly drained, to ensure freedom from retained surface water following periods of rain, and kept completely free of weed growth or discarded timber.

14. Of major importance is the provision of covering to prevent the continued rewetting of drying stacks. This may take the form of one or more large open-sided sheds each capable of holding a considerable number of stacks; or a much greater number of smaller ones, each capable of taking only 2 to 4 stacks, and separated sideways and endways by alleys sufficiently wide to permit the movement of handling vehicles, e.g. side or end-loading fork trucks or mobile jib cranes.

15. Modern yard design tends to favour the smaller shed, as it ensures rapid and economic handling and maximum drying rate. With the large shed there is a grave risk of over-filling and restricting air movement unduly, thus accentuating the likelihood of delayed and uneven drying. Probably the greatest hazard with the small, isolated drying sheds is from driving rain: here the use of cane or bamboo blinds, or removable, light, slatted frames along the sides of the sheds is of considerable value.

Pre-driers and Pre-drying

16. Pre-driers are large, low-cost timber driers with forced-air circulation and, preferably, some form of heating - usually steam - to ensure accelerated drying conditions. They arose from the need for a substitute for partial air drying to moisture contents in the vicinity of fibre saturation point in cool temperate zones subject to adverse weather conditions and recently, they have been considered for use in moist tropical conditions, and the construction of a prototype for use in Bangkok, Thailand, has now been completed.

17. During the early stages of seasoning, i.e. above fibre saturation point, pre-driers are capable of accelerating drying to a rate equal to that obtainable from kilns. Their application appears to be suitable for the partial preliminary drying of sawn and round wood in all forms, including timbers for some engineering structures, and products of the less durable species requiring drying before and after preservative treatment, e.g. sleepers, bridge timbers, and poles and cross arms.

18. Some special advantages of pre-drying are: a reduction in drying time, at moisture contents above fibre saturation point, to some 10 to

20% of that required for air drying; convenience where land space is inadequate for air drying; continuity of output irrespective of weather conditions; flexibility in changing production schedules to meet urgent market demands; and avoidance of secondary problems from staining, insect attack, weather damage, and re-wetting.

19. It is emphasized that pre-driers cannot normally be justified economically where air drying conditions are predominantly good, i.e. in areas subject to protracted warm, dry conditions, and that in general they are less attractive than kilns for final drying to moisture-contents less than 20 to 25%.

KILN DRYING

20. A trend towards kiln drying is undoubtedly favoured by improving living standards and increasing industrialization, such as are evident in parts of south-east Asia, Africa, and Central and South America. However, for economic reasons some timber sizes are not usually kiln dried, even if facilities are available, except as a matter of urgency, e.g. thicknesses greater than 2 in. For the same reason, kiln drying from the green condition is mostly restricted to softwoods or thin hardwoods for case stock or special products.

21. The most technically and economically attractive seasoning practice for most hardwoods is a combination of partial air drying, or pre-drying to a moisture content in the vicinity of 20 to 25%, followed by kiln drying, and such final stress relief or other treatments as may be warranted, e.g. moisture conditioning or reconditioning. It also has advantages where large stock holding is impracticable, for custom drying, and when continuity of output is necessary at low moisture contents. However, in humid tropical areas certain special seasoning problems can develop. These are mainly due to the large volume of sapwood in trees of some tropical species, and the mixed-species nature of much tropical forest. In these cases segregation or aggregation for seasoning purposes may be necessary. For the large organization, segregation is desirable, so that each variable can be treated in the manner best suited to its needs without jeopardy to the uniformity of final moisture content or drying costs. For the small operation, complete segregation could lead to the slow rising of stacks, causing a risk of considerable moisture variation within stacks, and to surface checking in stack layers progressively exposed to the sun.

22. In these conditions aggregation is warranted, but caution is needed; in many cases not only should seasoning behaviour of the different timbers be similar, but also other characteristics, e.g. durability and behaviour under insect attack.

23. Careful attention to the packaging of kiln seasoned timber for export may be necessary. Some export markets specify low moisture content limits, requiring kiln drying to well below the local equilibrium moisture content. In this event subdivision of the order into unit packages immediately after seasoning and wrapping with a water and vapour-proof sheet e.g. polythene, would seem a satisfactory procedure.

KILN DESIGN AND CONSTRUCTION

24. When tropical forest contains many different species this often leads to the conversion of a wide range of timbers, in which circumstances the smaller compartment type kiln, providing a choice of sizes extending from, say, 500 to 1000 cu ft per charge, undoubtedly has advantages over

the larger compartment or the progressive unit, particulary where plant throughput is comparatively small.

25. Kiln design and construction for humid tropical areas involves no radical changes from that for more temperate zones. However, some economies in kiln construction may be made, as heat insulation is not so critical, and some redesign of venting, to allow for the high humidity of the external air, may be necessary.

26. For kiln charging and discharging, the choice lies between the use of kiln trucks, the Christensen-type lifting truck, and straddle or fork-lift trucks. From considerations of reliability, simplicity and economy, the Christensen system is recommended, with yard-handling to the kiln site being carried out by any of a Christensen truck, a fork lift truck, a straddle truck, a mobile crane, or an overhead travelling crane, whichever is most convenient.

ECONOMIC FACTORS

27. In favourable climates air drying to moisture contents of the order of 25% is invariably cheaper than pre-drying or kiln drying, in both capital investment and drying cost.

28. On the other hand, where climatic conditions are adverse for an appreciable part of the year and air drying is prolonged, it usually means a large expenditure in drying stock and yard facilities to hold and service this stock, i.e. access roadways, handling equipment, stack supports, stack covering, yard drainage, fencing, fire protection and the like. In this case capital expenditure for air drying can exceed that for pre-drying. However, pre-drying direct costs will usually remain higher because of the heating, and to a lesser extent, the power charges involved.

29. Pre-drying is usually much cheaper than kiln drying from considerations of both capital investment and drying cost where the drying of tropical hardwoods needs to be accelerated at moisture contents above the fibre saturation point.

30. Kiln drying is, therfore, the most costly of all three methods of seasoning, but for a number of reasons is generally the most attractive for drying to low values from moisture contents below the fibre saturation point. The question of choice between combined partial air drying and kiln drying, or combined pre-drying and kiln drying is, in some cases, dependent on the extent to which stack covering is provided, and facilities for rapid processing for, say, custom drying, are necessary to ensure patronage, even if this is at the expense of greater drying cost.

31. For pre-drying and kiln drying the major items of cost are overhead and heating charges; fuel cost contributes to the latter very considerably Important measures for economic operation are, therefore, low-cost building construction and a cheap fuel; one of the cheapest is wood waste, e.g. sawdust, planer shavings and sawmill offcuts.

SEASONING OF ROUND AND LARGE SAWN TIMBERS

32. Time and economic considerations rarely favour the seasoning of round or large sawn timbers of naturally durable species for general construction purposes, e.g. poles, posts, cross arms, sleepers, or dwarf or bridge timbers. However, the development of the wood pre-

servation industry has enabled the successful utilization of sapwood and timber species not naturally durable for many purposes where an extended service life is required, even under the conditions of high decay and insect hazard commonly encountered in humid tropical regions.

33. In many cases the required protection is best obtained by a pressure process for which some pre-seasoning is necessary, usually to a moisture content approximating 30% in those zones in the wood which require treatment. Pre-seasoning, or post-seasoning may be obtained by air drying, or an accelerated process such as pre-drying, boultonizing, steam-and-vacuum drying, or vapour drying.

34. The selection of the seasoning process depends as for other timbers on the conditions in the timber yard and the financial considerations involved. Where an accelerated method is favoured, pre-drying is probably the most flexible and the simplest to control. On the other hand, boultonizing, steam-and-vacuum drying and vapour drying, while somewhat less versatile, give very much faster drying times and more rapid throughput.

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